Research on Digital Virtual Humans in the Metaverse for Smart Teaching

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Abstract: With the rapid development of information technology and artificial intelligence, the virtual digital world known as the metaverse has become an important extension of the real world. This paper aims to explore the design, implementation, and application of digital virtual humans in the metaverse for smart teaching. Firstly, starting from the concept and characteristics of digital virtual humans, we introduce the current development status and application scenarios of digital virtual humans. Then, we expound on the concept of smart teaching and discuss the roles of digital virtual humans in smart teaching, such as teaching assistants, personalized learning tutors, and simulated learning environments. We also analyze the advantages and challenges of digital virtual humans in smart teaching, including aspects like language understanding, emotion recognition, and privacy security. Finally, this paper discusses the development trends and challenges of digital virtual humans, providing new ideas and directions for the education field, exploring how to achieve smart teaching in the virtual world, in order to better meet the learning needs of students and improve the quality and effectiveness of education.

Keywords: Virtual humans, metaverse, smart teaching

1. Introduction

In recent years, with the rapid development of information technology and the increasingly mature artificial intelligence technology, the metaverse, a virtual digital world, is rapidly becoming an important extension of our real world. The metaverse is a type of virtual reality space that can simulate real physical space and social environments, providing rich immersive experiences. As a digital environment, the metaverse not only offers immersive experiences but also brings unlimited innovation and possibilities, especially in the field of education [1]. In the metaverse, virtual digital humans, as important digital representations, can simulate human language, movements, and behaviors, bringing unprecedented possibilities for education and learning. Virtual digital humans can play various roles, assisting teachers in classroom teaching, providing personalized learning services to students, and even serving as companions and assistants in the learning process [2].

Smart teaching, as a new teaching model, has attracted increasing attention due to its characteristics of personalization, interactivity, and innovation [3]. Smart teaching emphasizes that education should focus on students, emphasizing personalized learning and fully leveraging the teaching abilities of teachers and the learning capabilities of students [4]. Smart teaching requires the utilization of a large amount of data and information to meet students' personalized learning needs,

help teachers better assess students' learning outcomes and teaching effectiveness, optimize teaching methods and strategies, thereby improving the quality and effectiveness of teaching. In the metaverse, how to utilize virtual digital humans to achieve smart teaching has become an urgent issue to be addressed in the field of education [5].

Therefore, this paper will explore the design and implementation of virtual digital humans in the metaverse, as well as how to utilize virtual digital humans to achieve smart teaching. We will start by discussing the concept and characteristics of virtual digital humans, introducing the implementation methods and application scenarios of virtual digital humans. Then, we will discuss the applications of virtual digital humans in education, particularly their role in teaching assessment. Next, we will focus on introducing the concept and role of smart teaching and explore how virtual digital humans can be used for smart teaching assessment. Finally, we will discuss the development trends and challenges of virtual digital humans, analyzing the problems and opportunities they may face in the future. Through the discussion of the design and implementation of virtual digital humans in the metaverse, this paper aims to provide new ideas and directions for the education field, exploring how to achieve smart teaching in the virtual world, in order to better meet the learning needs of students, improve the quality and effectiveness of education, and inject new vitality and momentum into the development of the education field.

2. Virtual Digital Humans in the Metaverse

2.1. Concept and Characteristics of Digital Virtual Humans

Digital virtual humans are virtual characters that combine digital technology and artificial intelligence technology, capable of simulating human appearance, behavior, and communication styles, while possessing unique personalities and abilities. In the metaverse, they serve as digital representatives, providing users with diverse interactive experiences.

Virtual digital humans possess at least three characteristics: human appearance, with specific features such as appearance and gender; human behavior, with the ability to express specific language, facial expressions, and body movements; human thought, with the ability to recognize the external environment and communicate with humans [6]. Firstly, their appearance is typically based on human models from the real world, capable of simulating various elements such as skin color, hairstyles, clothing, and accessories, providing users with rich visual experiences. Secondly, digital virtual humans can simulate various human behaviors, such as walking, running, jumping, and gestures, allowing users to experience human-like behaviors during interaction. Additionally, digital virtual humans possess language understanding and generation capabilities, enabling real-time text or voice communication with users, providing a more natural and fluent communication experience. Furthermore, digital virtual humans can simulate human emotional expressions, such as joy, anger, sorrow, and happiness, based on context and situation, allowing users to experience more authentic emotional communication during interaction. In terms of autonomous learning, digital virtual humans have the ability to learn autonomously and adapt, continuously optimizing their models and strategies based on user feedback and behavior to better meet user needs. Lastly, digital virtual humans can be personalized and customized according to user preferences and requirements, providing users with unique virtual characters and experiences [7].

2.2. Application Scenarios of Digital Virtual Humans

2.2.1. Virtual Socialization

In the social platforms of the metaverse, digital virtual humans can play various roles such as friends, guides, or advisors, engaging in real-time interaction with users, providing emotional support, information services, and problem-solving functions. For example:

• As Friends: Digital virtual humans can communicate with users based on their interests and preferences, building deep friendships and fulfilling users' emotional needs.

• As Guides: Digital virtual humans can provide guided tour services for users in virtual landmarks, introducing the history and cultural background of the landmarks, enhancing users' travel experiences.

• As Advisors: Digital virtual humans can provide professional advice and solutions based on users' needs and problems, helping users solve real-life issues.

2.2.2. Entertainment and Gaming

In the entertainment and gaming fields, digital virtual humans can serve as game characters, performers, or audience members, providing users with rich entertainment and gaming experiences. For example:

• As Game Characters: Digital virtual humans can act as players' game characters or teammates, participating in various gaming activities, offering players a more realistic and immersive gaming experience.

• As Performers: Digital virtual humans can serve as performers in virtual concerts, theater performances, or movies, collaborating with real-world artists to create and perform, providing audiences with unique audiovisual enjoyment.

• As Audience Members: Digital virtual humans can also act as audience members in online events, engaging in real-time interaction to create a more lively atmosphere for the event.

2.2.3. Commercial Applications

In the business domain, digital virtual humans can serve as brand ambassadors, customer service representatives, or marketing consultants, assisting companies in enhancing brand awareness, expanding market share, and optimizing customer experience. For example:

• As Brand Ambassadors: Digital virtual humans can develop unique images and personalities based on brand image and values, attracting consumer attention and enhancing brand image.

• As Customer Service Representatives: Digital virtual humans can provide 24/7 consultation, complaint, and suggestion services in online customer service centers, improving customer satisfaction and loyalty.

• As Marketing Consultants: Digital virtual humans can utilize market data and consumer behavior analysis to develop more precise and effective marketing strategies for enterprises, enhancing marketing effectiveness and return on investment.

3. Application of Digital Virtual Humans in Smart Teaching

3.1. What is Smart Teaching

Chen Jing proposed that smart teaching shifts from "imparting knowledge" to "cultivating wisdom," using wise approaches to cultivate students' wisdom literacy [2]. Yang Xianmin and Yu Shengquan proposed that smart teaching refers to teaching activities conducted by teachers in a smart teaching environment using various advanced information technologies and rich teaching resources. Smart

teaching aims to enhance teachers' teaching wisdom, promote teachers' professional development, and cultivate innovative talents. It can effectively improve the mechanical, inefficient, and insufficiently participative phenomena existing in traditional classroom teaching, possessing characteristics such as efficiency, openness, diversity, interactivity, and deep interaction [3]. Xu Mei and Zhang Yinghui proposed that smart teaching refers to enabling teachers to apply efficient teaching methods and providing learners with personalized learning services and better experiences through the construction of technology-integrated learning environments [4].

In summary, this study believes that smart teaching is a student-centered teaching model that emphasizes personalized learning and fully leverages the teaching abilities of teachers and the learning capabilities of students. By utilizing a large amount of data and information, smart teaching meets students' personalized learning needs, helps teachers better assess students' learning outcomes and teaching effectiveness, optimizes teaching methods and strategies, thereby improving the quality and effectiveness of teaching. In the metaverse, the application of digital virtual humans provides new possibilities for smart teaching.

3.2. Role of Digital Virtual Humans in Smart Teaching

3.2.1. Teaching Assistant

Digital virtual humans can serve as teaching assistants, aiding teachers in classroom instruction. They can simulate real teachers, explaining course content to students and providing real-time feedback and suggestions. Through natural language interaction with students, digital virtual humans can understand students' needs and confusion, offering targeted guidance and assistance.

3.2.2. Personalized Learning Tutor

Digital virtual humans can provide personalized learning services for each student. Based on students' learning abilities, interests, and progress, digital virtual humans can generate personalized learning plans and teaching resources. This helps improve students' learning outcomes and stimulate their interest and potential for learning.

3.2.3. Simulated Learning Environment

In the metaverse, digital virtual humans can provide students with simulated learning environments. Through virtual scenes, students can engage in practical exercises in a safe and comfortable environment, enhancing learning effectiveness. For example, in medical education, digital virtual humans can simulate patients, allowing students to practice in simulated clinical environments.

3.3. Selection of Platforms for Creating Digital Virtual Humans

This study conducted a comparative analysis of digital platforms such as Tencent Cloud Intelligent Digital Humans, LAiPIC, and D-ID, selecting the most suitable platform for designing digital virtual humans based on teaching needs. The scoring form ranged from 1 to 5 points. The comparison is shown in Table 1.

Table 1: Comparison of Digital Virtual Human Platforms

	Tencent Cloud Intelligent Digital Humans	LAiPIC	D-ID
Ease of Use	Guided Usage (5 points)	Guided Usage (5 points)	Guided Usage (5 points)

Table 1: (continued).

Language Diversity	Chinese (4 points)	Chinese (4 points)	English (2 points)
Novice Friendliness	Relatively friendly (3 points)	Friendly (4 points)	Language issues exist (2 points)
Interface Aesthetics	Rich (4 points)	Beautiful (3 points)	Simple (3 points)
System Smoothness	Easily lags (2 points)	Smooth (4 points)	Occasional lags (3 points)
Optional Content	Rich, diverse interaction (4 points)	Rich (4 points)	Rich (4 points)
Cost	Numerous chargeable items (3 points)	Charge for advanced features (4 points)	Charge for advanced features (4 points)
Overall Evaluation	25 points	28 points	23 points

The Tencent Cloud Intelligent Digital Humans platform offers a clear and concise operational interface and process, adopting a modern design style. The interface is simple and generous, with harmonious color matching, providing users with a pleasant user experience. The platform employs efficient algorithms and advanced technical architecture. However, during the design process, the network interface is prone to lagging and demands high network requirements.

The LAiPIC platform is a powerful and highly creative digital content creation tool, favored by users for its ease of use, multilingual support, novice friendliness, beautiful interface, smooth system operation, stable network, and rich optional content.

The D-ID platform is primarily an English-based digital virtual human creation platform, with a higher requirement for user language proficiency. This multilingual support feature makes the D-ID platform more inclusive and global. Additionally, the platform adopts a modern design style with a reasonable interface layout and harmonious color matching, providing users with a pleasant user experience.

In summary, considering aspects such as platform system smoothness, ease of use, and cost, this study selects the LAiPIC Digital Human platform for this exploration.

3.4. Achieving Digital Virtual Humans in Smart Teaching

3.4.1. Choosing a Digital Virtual Human Platform

This study selects the LAiPIC (AI FOR ALL) platform. LAiPIC is a company jointly established by Shenzhen, China, and Abu Dhabi AIGC in the United Arab Emirates, founded in Qianhai, Shenzhen, on July 30, 2015. Since its establishment, LAiPIC has relied on its own 18 million animation data assets, independently developed the SkinSoul animation model, integrated seven core technological capabilities, and created controllable AI videos and tangible AI assistants. It is committed to helping global enterprises acquire the ability to generate videos and enabling global consumer electronics products to have visual interactive capabilities. It combines attractive appearance (Skin) with interesting personality (Soul) to realize the next generation of interactive methods using AI.

- LAiPIC: Shenzhen, China - Abu Dhabi, UAE, AIGC Company
- Positioning: Controllable AI videos and image-based AI assistants
- Vision: Realizing the next generation of interactive methods using AI

3.4.2. Constructing Digital Virtual Humans

As shown in Figure 1, constructing digital virtual humans mainly involves three steps: requirements analysis, virtual human creation, and publishing and optimization.
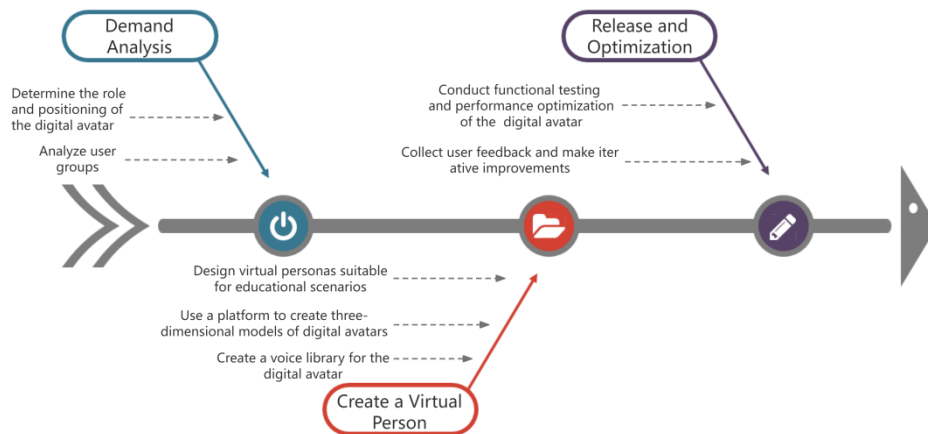

Figure 1: Steps to Construct Digital Virtual Humans

3.4.3. Roles of Digital Virtual Humans

• Requirements Analysis: Educational digital virtual humans can serve as personalized learning companions for students, providing customized learning resources and suggestions based on students' learning situations and needs. They can analyze students' learning progress, grades, and interests to offer precise learning plans and resource recommendations, assisting students in learning more efficiently. As shown in Figure 2, on the LAiPIC platform, select "My Digital Human" to enter the digital human creation interface. In the anchor interface, choose a suitable digital human image and upload the knowledge content to be explained as the background. Adjust the size and position of the digital human according to the content being explained, as shown in Figure 3.
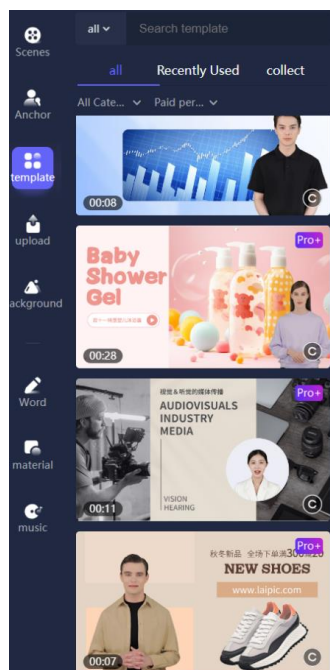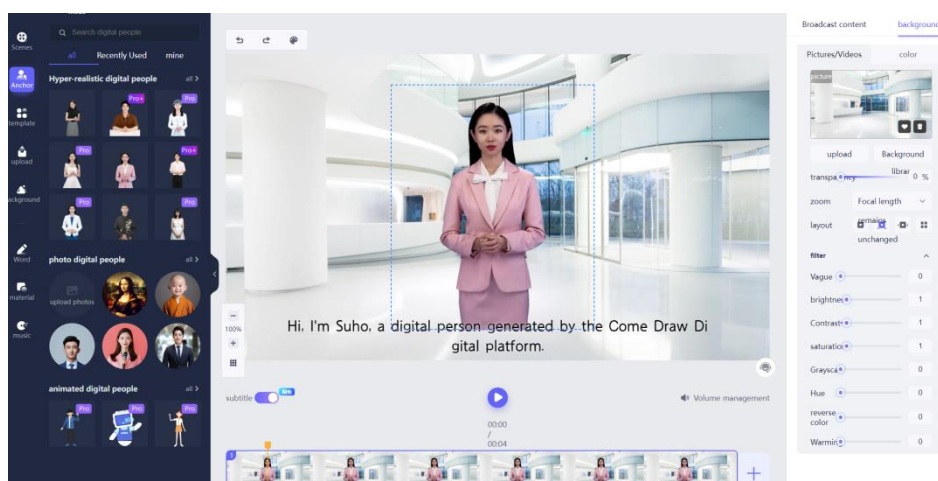

Figure 2: My Digital Human

Figure 3: Selecting a Digital Human Image

• Creating Virtual Humans: (1) Educational digital virtual humans can employ multimedia, interactive, and other teaching methods to enhance students' learning interests and enthusiasm. They can interact with students in various forms such as voice, images, and videos, enabling students to learn in a relaxed and enjoyable atmosphere, thereby improving learning effectiveness. As shown in Figure 4, design relevant textual content, create subtitles, save and generate audio, and finally produce dynamic teaching videos. (2) Educational digital virtual humans can intelligently provide tutoring and Q&A services to students based on their learning situations. During the post-production phase, they offer detailed explanations and examples to help students better understand and master the knowledge points, addressing students' questions and uncertainties according to their learning situations.
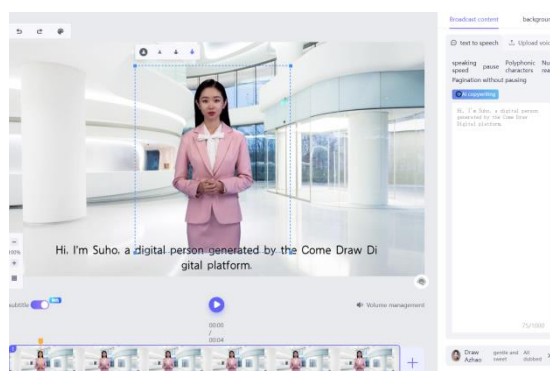

Figure 4: Designing Teaching Content

• Publishing and Optimization: After completing video production, export and publish the video. Based on student feedback, timely improvements can be made to the teaching content. Educational digital virtual humans can manage and evaluate students' learning processes, providing timely feedback and suggestions. They can record students' learning progress, grades, and performance, offering personalized learning advice and improvement directions to help students better plan their learning paths.

In conclusion, educational digital virtual humans, as emerging technologies in the field of education, can provide students with more personalized, efficient, and enjoyable learning experiences, promoting students' learning development and enhancing learning effectiveness.

4. Development Trends and Challenges of Virtual Digital Humans

4.1. Future Development Trends of Virtual Digital Humans

The intelligence of virtual digital humans is an important trend for future development. With the continuous advancement of artificial intelligence technology, the interaction methods and expressive abilities of virtual digital humans will further improve, becoming more realistic and vivid. Intelligent voice interaction will become one of the important interaction methods for digital virtual humans. Virtual digital humans can not only understand natural language but also express emotions, intentions, and personalities, enhancing user experience. Emotion recognition and expression technology will further develop, helping virtual digital humans better understand users' emotional states and needs. Additionally, intelligent learning and personalized recommendation technologies will also be widely applied to virtual digital humans, providing users with more personalized services.

With the continuous development of virtual reality and augmented reality technologies, the interaction methods of virtual digital humans will become more diverse and natural. Virtual reality and augmented reality technologies will be widely used in the interaction of virtual digital humans, increasing user immersion and interaction experience. Technologies such as motion capture and muscle sensors will be further improved to help virtual digital humans more naturally simulate human movements and actions. The application of brain-computer interfaces and neural technologies will enhance the control and interaction capabilities of virtual digital humans, bringing users more convenient interaction experiences.

The application scenarios of virtual digital humans will become increasingly widespread. In addition to applications in education, entertainment, and gaming, virtual digital humans will also be widely used in industries such as healthcare, finance, architecture, and manufacturing, bringing more convenience and innovation to people's work and lives. The rise of digital twin technology will further drive the application of virtual digital humans. Digital twin technology can help people build and manage entities in the physical world in the digital world, bringing more innovation and efficiency improvement to fields such as industrial manufacturing and urban planning. The deep integration with the physical world will become an important trend in the development of virtual digital humans.

4.2. Challenges and Difficulties of Virtual Digital Humans

The development of virtual digital humans also faces some challenges. Privacy protection and ethical issues are important considerations for the application of virtual digital humans. The collection and processing of personal information and behavioral data of virtual digital humans need to consider users' privacy and security issues. Technical standards and interoperability issues also need to be addressed. The application scenarios and forms of virtual digital humans are diverse, requiring the establishment of universal technical standards and interoperability specifications to improve their usability and scalability. The difficulty of maintaining the image of virtual digital humans is also a challenge. Virtual digital humans are susceptible to cyberattacks and human interference, necessitating the establishment of comprehensive maintenance and protection mechanisms.

The infinite possibilities of digital virtual humans are driving the development of the entire digital economy and may give rise to new cultural, artistic, and creative industries. Virtual digital humans will also bring more convenience and innovation, bringing more efficiency improvements and personalized services to people's work and lives. The development of virtual digital humans requires continuous pursuit of technological advancement, while also considering factors such as user needs, privacy protection, and ethical issues, to provide people with more convenient and personalized services.

5.   Conclusion

In the metaverse, virtual digital humans can serve as virtual teachers or learning companions, providing personalized educational services. They can customize personalized learning plans and provide targeted guidance and feedback based on students' learning progress and needs. This helps stimulate students' interest in learning, improve learning efficiency, and enhance learning outcomes. Additionally, virtual digital humans can engage in real-time interaction and communication with students through technologies such as natural language processing and speech recognition. This interactive learning experience helps students better understand and grasp knowledge, thereby enhancing learning effectiveness.

Virtual digital humans can also offer various learning modes, such as virtual experiments and gamified learning, making the learning process more vivid and interesting. In the metaverse, virtual digital humans can create a virtual learning environment, providing students with a safe and convenient space for learning. In this environment, students can engage in various learning activities such as autonomous learning, collaborative learning, and inquiry-based learning. This helps cultivate students' abilities in autonomous learning, collaboration, and innovative thinking. In the metaverse, virtual digital humans can serve as a platform for sharing educational resources. Through interaction and communication with virtual digital humans, students can access a wealth of learning resources and information, broadening their learning horizons. However, this study is still limited to existing platforms and has not independently developed a platform. In future research, we will design and develop a digital virtual platform independently and apply it in actual teaching.

In summary, virtual digital humans can also provide cross-regional and cross-school educational resource sharing services, promoting educational equity and balanced development. Virtual digital humans in the metaverse have various values and significances. They can support students in personalized educational services, interactive learning experiences, virtual learning environments, and sharing educational resources, thereby promoting educational innovation and sustainable development.

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